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DIODE STEP STRESS TESTING PROGRAM

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FINAL REPORT
FOR
JANTX 1N5619

JANUARY 1979

Prepared
For

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FOREWORD

This report is a summary of the work performed on NASA Contract NAS8-31944. The investigation was conducted for the National Aeronautics and Space Administration, George C. Marshall Space Flight Center, Huntsville, Alabama. The Contracting Officer's Technical Representative was Mr. F. Villella.

The short-term objective of this preliminary study of transistors, diodes and FETs was to evaluate the reliability of these discrete devices, from different manufacturers, when subjected to power and temperature step stress tests.

The long-term objective will be to gain more knowledge of accelerated stress testing for use in future testing of varieties of discrete devices, as well as to determine which type of stress should be applied to a particular type of device or design.

This report is divided as follows: description of tests, figures, tables, and appendix.



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1.0 INTRODUCTION/SCOPE

DCA Reliability Laboratory, under contract NAS8-31944 for NASA/Marshall Space Flight Center, has compiled data for the purpose of evaluating the effect of power/temperature step stress when applied to a variety of semiconductor devices. This report covers the Diode JANTX1N5619 manufactured by Semtech and Micro-Semiconductor.

1.1 Sample Distribution

A total of 48 samples from each manufacturer were submitted to the process outlined in Table I. In addition, two control units were maintained for verification of the electrical parametric testing.

2.0 TEST REQUIREMENTS

2.1 Electrical

All test samples were subjected to the electrical tests outlined in Table II after the prior power/temperature step stress point. These tests were performed using the Fairchild Model 600 high-speed computer-controlled test system. In addition to the computer testing, additional bench testing was required on the devices.

2.2 Stress Circuit

The test circuit shown in Figure 1 was used to power all of the test devices during the power/temperature stress conditions. The voltage was set by V_F and the current was varied in order to comply with the specified power rating for this device. At least one of the test devices was subjected to maximum rated power (MRP). All the



remaining devices were subjected to no less than 90 percent of MRP. See Figure 1 for load resistor values and voltages.

2.3 Group I - Power Stress

Thirty-two units, 16 from each manufacturer, were submitted to the power stress process. The diodes were stressed in 500-hour steps at 50, 100, 125, 150 and 175 percent MRP for a total of 2500 hours or until 50 percent or more of the devices in a sample lot failed.* Electrical measurements were performed on all specified electrical parameters after each power step; see Table I.

2.4 Group II - Temperature Stress I

Thirty-two units, 16 from each manufacturer, were submitted to the Temperature Stress I process. Group II was subjected to a total of 1600 hours of stress at MRP in increments of 160 hours. The temperature was increased in steps of +25°C, commencing at +75°C and terminating at +300°C or until 50 percent or more of the devices failed.* Electrical measurements were performed on all specified electrical parameters after each temperature step; see Table I.

2.5 Group III - Temperature Stress II

Thirty-two units, 16 from each manufacturer, were submitted to the Temperature Stress II process. Group III

*Conditions for failure:

- A) Open or short
- B) Leakage exceeds the MIL limit by 100 times
- C) Other parameters exceed MIL limits by 50 percent or greater



was subjected to a total of 112 hours of stress at MRP in increments of 16 hours. The temperature was increased in steps of +25°C, commencing at +150°C and terminating at +300°C or until 50 percent or more of the devices in a sample lot failed.* Electrical measurements were performed on all specified electrical parameters after each temperature step; see Table I.

3.0 DISCUSSION OF TEST RESULTS

3.1 Group I - Power Stress

3.1.1 Semtech. The Semtech sample lot completed the 2500-hour power stress testing with a total of two catastrophic failures. The first failure occurred 150 hours into the 175 percent MRP step. Serial Number 7712 failed because of excessive I_R leakage. The last failure occurred 500 hours into the 175 percent MRP step. Serial Number 7718 failed the minimum V_F limit. Typical characteristics of this sample lot's performance were:

- 1) The mean value for I_R changed 74.78nA from an initial mean of 81.82nA to a final mean of 156.6nA.
- 2) The mean value for V_F changed 73.0mV from an initial mean of 1.19V to a final mean of 1.117V.

The control units for this sample lot remained constant throughout the entire Group I testing.

*Conditions for failure:

- A) Open or short
- B) Leakage exceeds the MIL limit by 100 times
- C) Other parameters exceed MIL limits by 50 percent or greater.



3.1.2 Micro-Semiconductor. The MSC sample lot completed a total of 1650 hours before the lot was stopped because more than 50 percent of the devices failed.* MSC experienced a total of 10 stress-related failures, all due to the anode leads detaching. Serial Number 7743 was removed 250 hours into the 125 percent MRP step. Serial Numbers 7745, 7755 and 7756 were removed 500 hours into the 125 percent MRP step. Serial Number 7754 was removed 25 hours into the 150 percent MRP step. Serial Numbers 7742, 7746, 7748, 7749 and 7752 were removed 150 hours into the 150 percent MRP step. Typical characteristics of this sample lot's performance were:

- 1) The mean value for I_R changed 43.5nA from an initial mean of 157.2nA to a final mean of 113.7nA.
- 2) The mean value for V_F changed 3.0mV from an initial mean of 1.317V to a final mean of 1.32V.

The control units for this sample lot remained constant throughout the entire Group I testing.

3.1.3 Statistical Summary - Group I. Table IV outlines the results of Group I - Power Stress process for both electrical parameters and all measurement points for both Semtech and Micro-Semiconductor.

3.2 Group II - Temperature Stress I

3.2.1 Semtech. The Semtech sample lot completed a total of 1120 hours before the lot was stopped because 50 percent

*Conditions for failure:

- A) Open or short
- B) Leakage exceeds the MIL limit by 100 times
- C) Other parameters exceed MIL limits by 50 percent or greater.



of the devices failed* at this point. The first failure occurred 160 hours into the +200°C temperature step. Serial Number 7722 failed because of excessive I_R leakage. The last failures occurred 160 hours into the +225°C temperature step. Serial Numbers 7697, 7698, 7699, 7720, 7724, 7725 and 7726 failed because of excessive I_R leakage. Typical characteristics of this sample lot's performance were:

- 1) The mean value for I_R changed 2.83mA from an initial mean of 55.5nA to a final mean of 2.83mA.
- 2) The mean value for V_F changed 19.0mV from an initial mean of 1.214V to a final mean of 1.195V.

The control units for this sample lot remained constant throughout the entire Group II testing.

3.2.2 Micro-Semiconductor. The MSC sample lot completed a total of 640 hours before the lot was stopped because more than 50 percent of the devices failed* at this point. The first failures occurred 160 hours into the +100°C temperature step. Serial Numbers 7757 and 7760 failed because of excessive I_R leakage. The next failures occurred 160 hours into the +150°C temperature step. Serial Number 7739 was removed from testing because the anode lead detached (from stress). Serial Numbers 7765 and 7767 failed because of excessive I_R leakage. The last failures occurred 160 hours into the +175°C temperature step. Serial Number 7761 failed because of excessive I_R leakage. Serial Numbers 7768, 7769 and 7770 were removed from testing

*Conditions for failure:

- A) Open or short
- B) Leakage exceeds the MIL limit by 100 times
- C) Other parameters exceed MIL limits by 50 percent or greater



because the anode leads detached (due to stress). Typical characteristics of the sample lot's performance were:

- 1) The mean value for I_R changed 102.81nA from an initial mean of 155.5nA to a final mean of 52.69nA.
- 2) The mean value for V_F changed 178.0mV from an initial mean of 1.407V to a final mean of 1.229V.

The control units for this sample lot remained constant throughout the entire Group II testing.

3.2.3 Statistical Summary - Group II. Table V of this report outlines the results of Group II - Temperature Stress I testing for the two electrical parameters and all the measurement points pertaining to both Semtech and Micro-Semiconductor.

3.3 Group III - Temperature Stress II

3.3.1 Semtech. The Semtech sample lot completed the entire 112-hour Group III testing with a total of two catastrophic failures. The two failures occurred 16 hours into the +300°C temperature step. Serial Numbers 7707 and 7728 failed because of excessive I_R leakage. Typical characteristics of this sample lot's performance were:

- 1) The mean value for I_R changed 190.55μA from an initial mean of 51.31nA to a final mean of 190.6μA.
- 2) The mean value for V_F changed 2.0mV from an initial mean of 1.217V to a final mean of 1.219V.

The control units for this sample lot remained constant throughout the entire Group III testing.

3.3.2 Micro-Semiconductor. The MSC sample lot completed the entire 112-hour Group III testing with a total of five catastrophic failures. The first failure occurred 16 hours into the +200°C temperature step. Serial Number 7773 failed because of excessive I_R leakage. The next failures occurred 16 hours into the +275°C temperature step. Serial Number 7786 failed because of excessive I_R leakage. Serial Number 7788 was removed from testing because the anode lead detached due to stress. The last failures occurred 16 hours into the +300°C temperature step. Serial Numbers 7740 and 7779 were removed from testing as visual rejects because the anode leads detached. Typical characteristics of this sample lot were:

- 1) The mean value for I_R changed 11.6nA from an initial mean of 151.0nA to a final mean of 162.6nA.
- 2) The mean value for V_F changed 8.0mV from an initial mean of 1.36V to a final mean of 1.352V.

The control units for this sample lot remained constant throughout the entire Group III testing.

3.3.3 Statistical Summary - Group III. Table VI outlines the results for Group III - Temperature Stress II testing for the two electrical parameters and all measurement points pertaining to both Semtech and Micro-Semiconductor.

4.0 FINAL DATA SUMMARY

Table VII summarizes the change in the mean value from the zero-hour data to the final data. The graphs of Figures 2 through 4 plot the cumulative percent failures versus the Temperature Stress level for Group II - Temperature Stress I, and Group III - Temperature II. The graphs of Figures 3 and 5 plot the time step for Group II (160 hours) and Group III (16 hours) versus the temperatures T_1 and T_2 calculated from Figures 2 and 4. Tables 8 and 9 summarize the failures encountered for all three



stress groups. The failures are separated into two categories: catastrophic failures in Table 8 and parametric failures in Table 9. The data from Table 8 was used as a source for the graphs in Figures 2 and 4. Figures 2 and 4 were used as a source for the graphs in Figures 3 and 5 respectively. Junction temperature is plotted on an inverse hyperbolic scale.

5.0

CONCLUSIONS

In the Group I testing only one of the manufacturers, Micro Semiconductor, experienced an excessive amount of catastrophic failures. The MSC sample lot had to be stopped because nine of the devices' external leads detached from the diode internal heat sink.

The Group II testing proved detrimental to both sample lots. The common parameter failed by both lots was I_R . Retesting these devices on the curve tracer shows that the curve trace is free of leakage until approximately 350 volts; from there to approximately 500 volts the curve is rounded, and then a final hard breakdown occurs. This suggests that the stress test has caused bulk silicon damage. Figure B-3 shows cracked and chipped-out metal at the external anode wire attachment of one of the Micro Semiconductor samples.

A plot showing cumulative failure distribution for Groups II and III Testing was drawn for Semtech and Micro-Semiconductor sample lots (Figures 2-3 and 4-5 respectively). Figures 2 and 3 display the data for the Semtech sample lot used to calculate an activation energy of 1.01eV. Figures 4 and 5 display the data for the Micro Semiconductor sample lot used to calculate an activation energy of .61eV.



A broken circle around a marked point on the graph indicates a freak failure not calculated as part of the regression line. A solid circle around a marked point indicates an isolated failure point. The regression line was drawn using the least square method.

In Figure 4, the Group III failure point at 450° was not calculated into the regression line because of a change in the failure mechanism at that temperature.

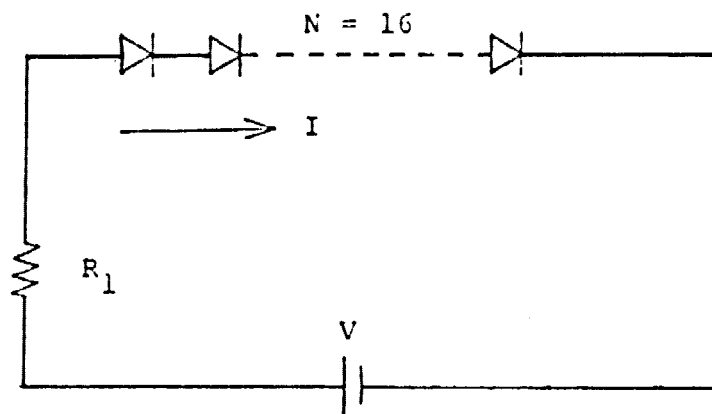
The activation energy was calculated from the formula:

$$E = \left[\ln \left(\frac{t_1}{t_2} \right) \right] \left[\frac{8.63 \times 10^{-5} \text{ eV/}^\circ\text{K}}{\left(\frac{1}{T_1 + 273} \right) - \left(\frac{1}{T_2 + 273} \right)} \right] \text{ eV}$$

Where: t_1 = step of Group II - Temp Stress I = 160 hrs.
 t_2 = step of Group III - Temp Stress II = 16 hrs.
 T_1 = temperature in $^\circ\text{C}$ of 16% failure for Group II.
 T_2 = temperature in $^\circ\text{C}$ of 16% failure for Group III.



JANTX1N5619



NOTES: $R_1 = \frac{1V}{I} \pm 1\%$

$$P_d = IE$$

FIGURE 1

Power and Temperature Stress Circuit
for JANTX1N5619

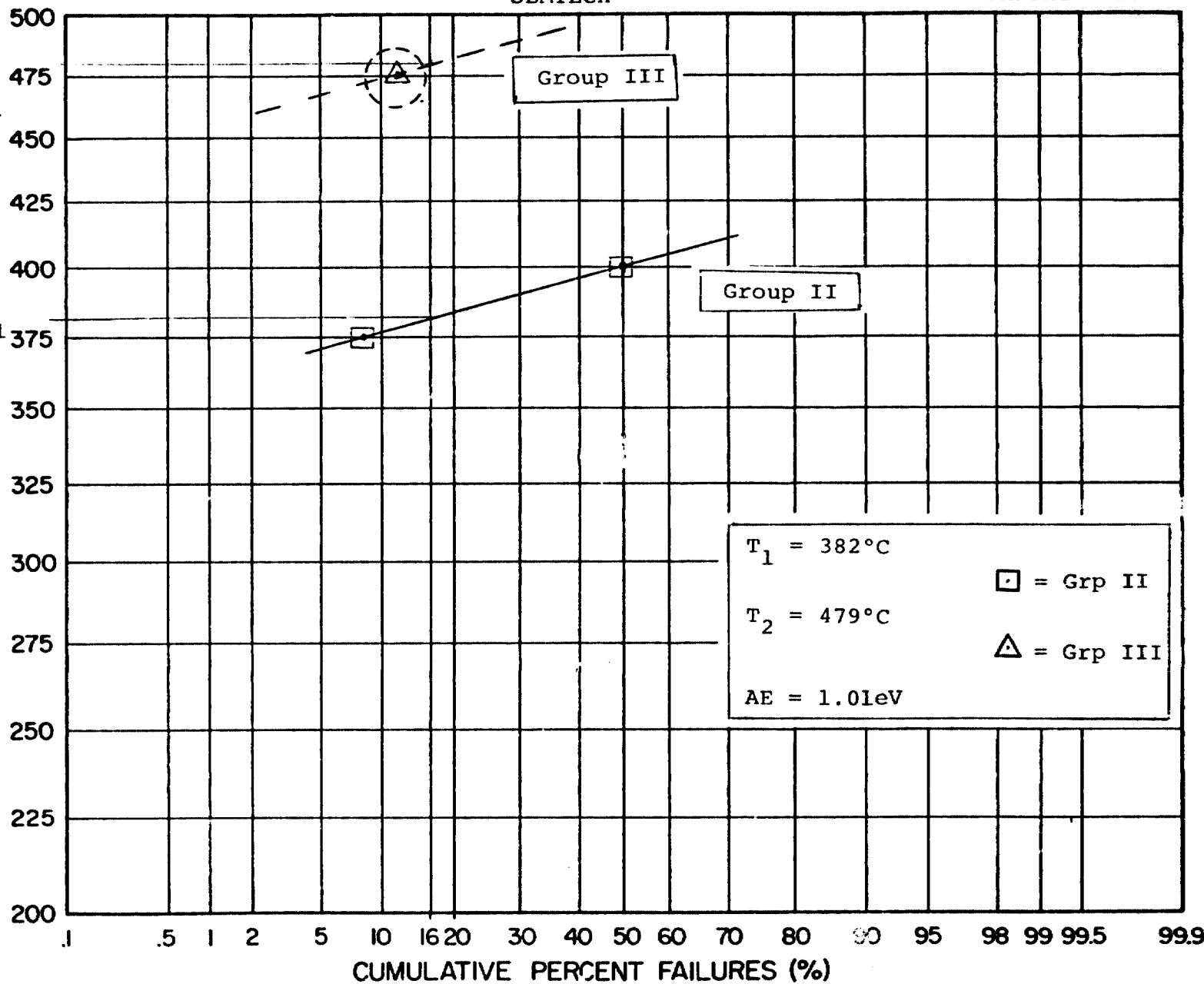


SEMTECH

JANTX1N5619

 T_2

* JUNCTION TEMPERATURE (°C)

 T_1 

*NOTE

$$T_J \approx T_A + 175^\circ\text{C}$$

FIGURE 2

Cumulative Percent Failures Versus Junction Temperature, Semtech

JANTX1N5619



SEMTECH

JANTXIN5619

* JUNCTION TEMPERATURE (°C)

 T_2 T_1

VII

 $T_1 = 382^\circ\text{C}$ $T_2 = 479^\circ\text{C}$

AE = 1.01eV

*NOTE

$$T_J \approx T_A + 175^\circ\text{C}$$

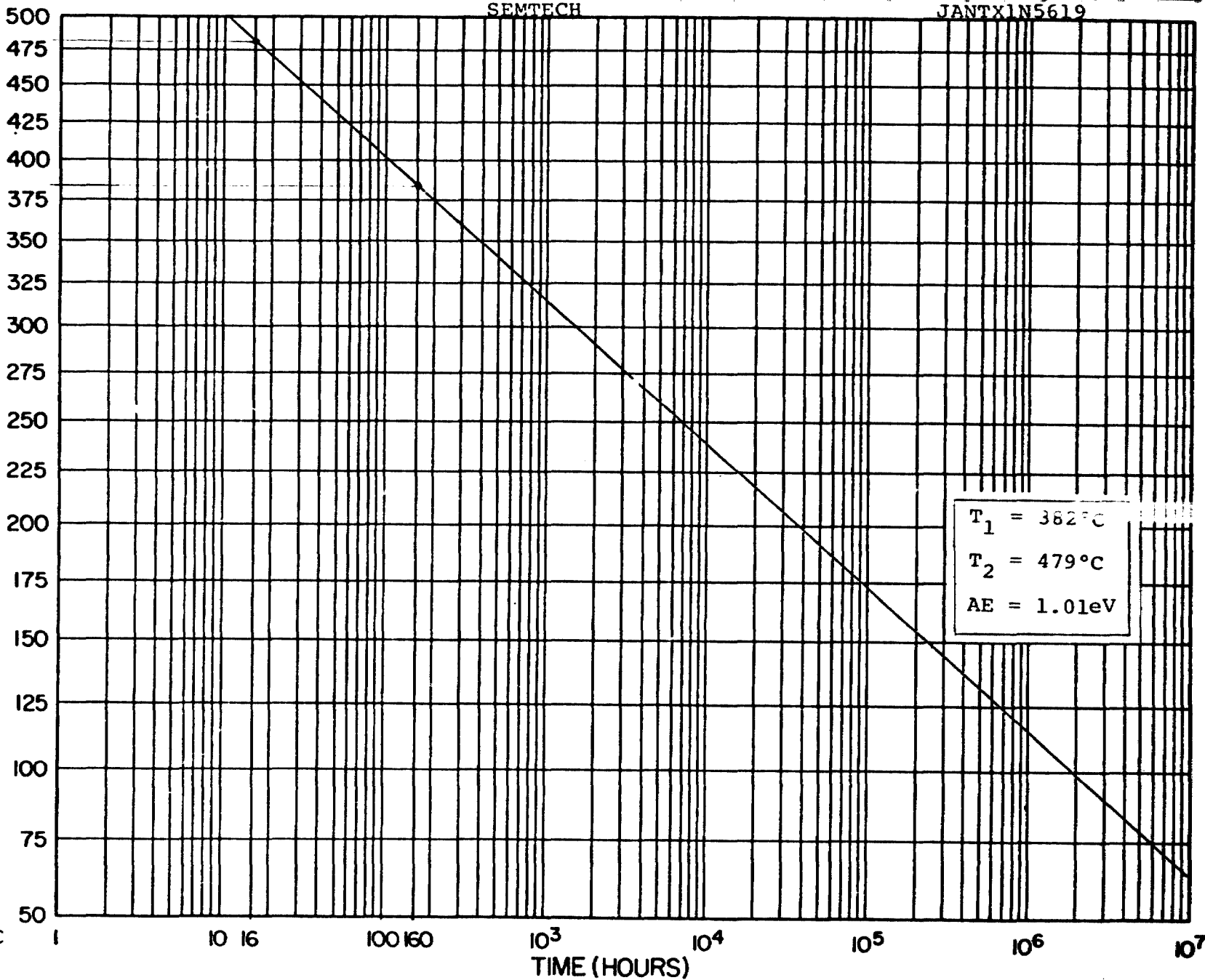


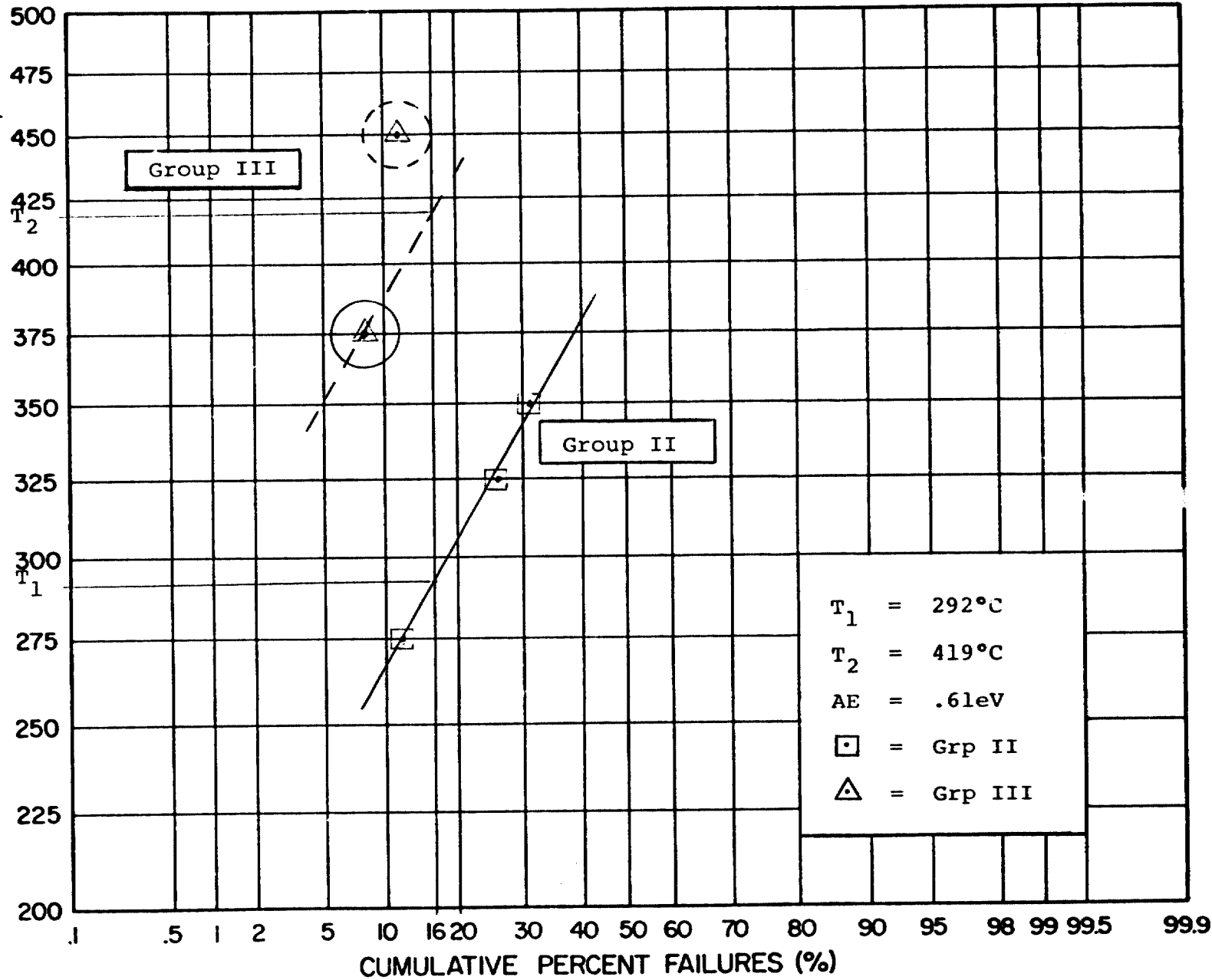
FIGURE 3

Time Steps Versus Temperature, Semtech

JANTXIN5619



* JUNCTION TEMPERATURE (°C)



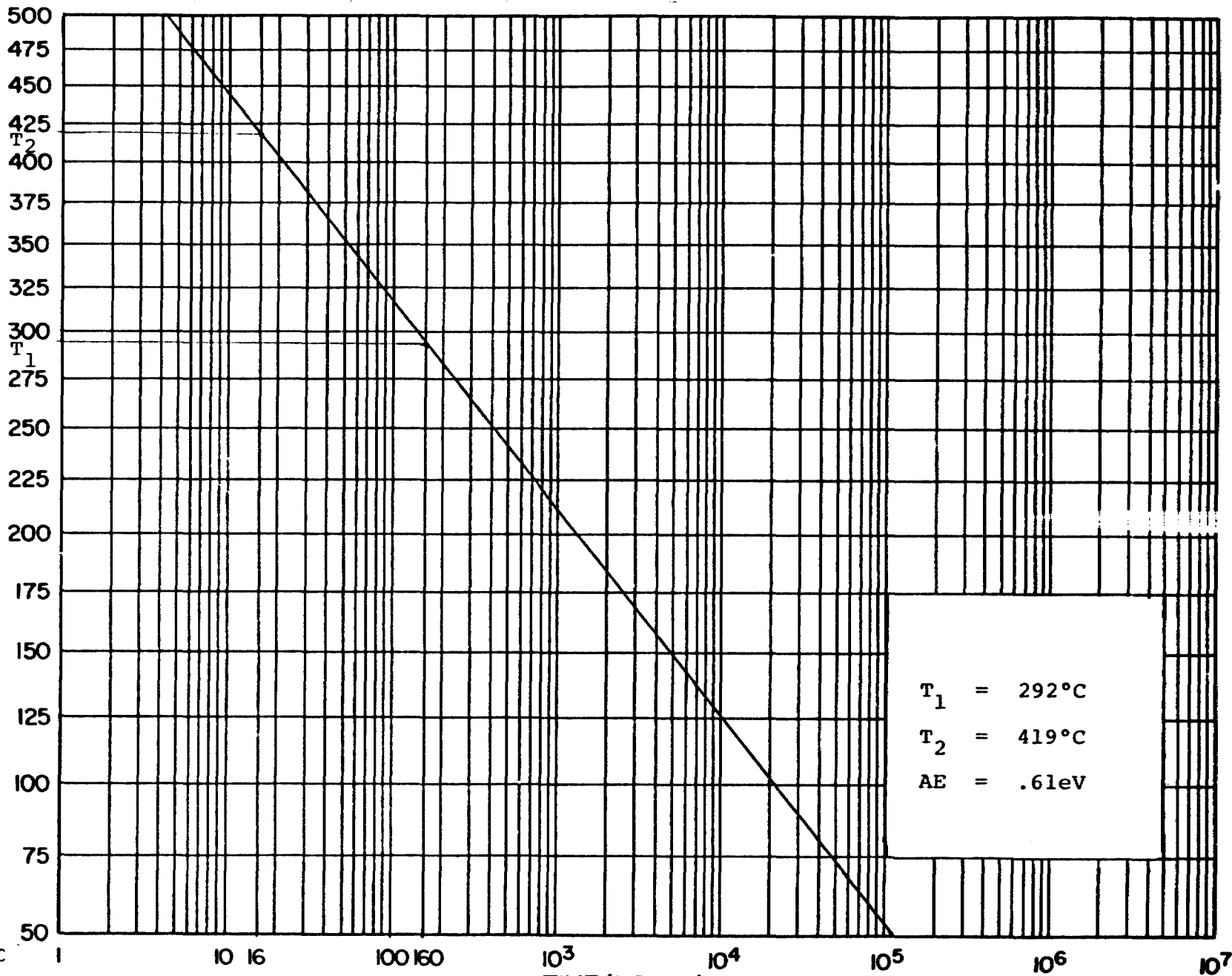
JANTX1N5619

FIGURE 4

Cumulative Percent Failures Versus Junction Temperature, Micro Semiconductor



* JUNCTION TEMPERATURE (°C)



*NOTE

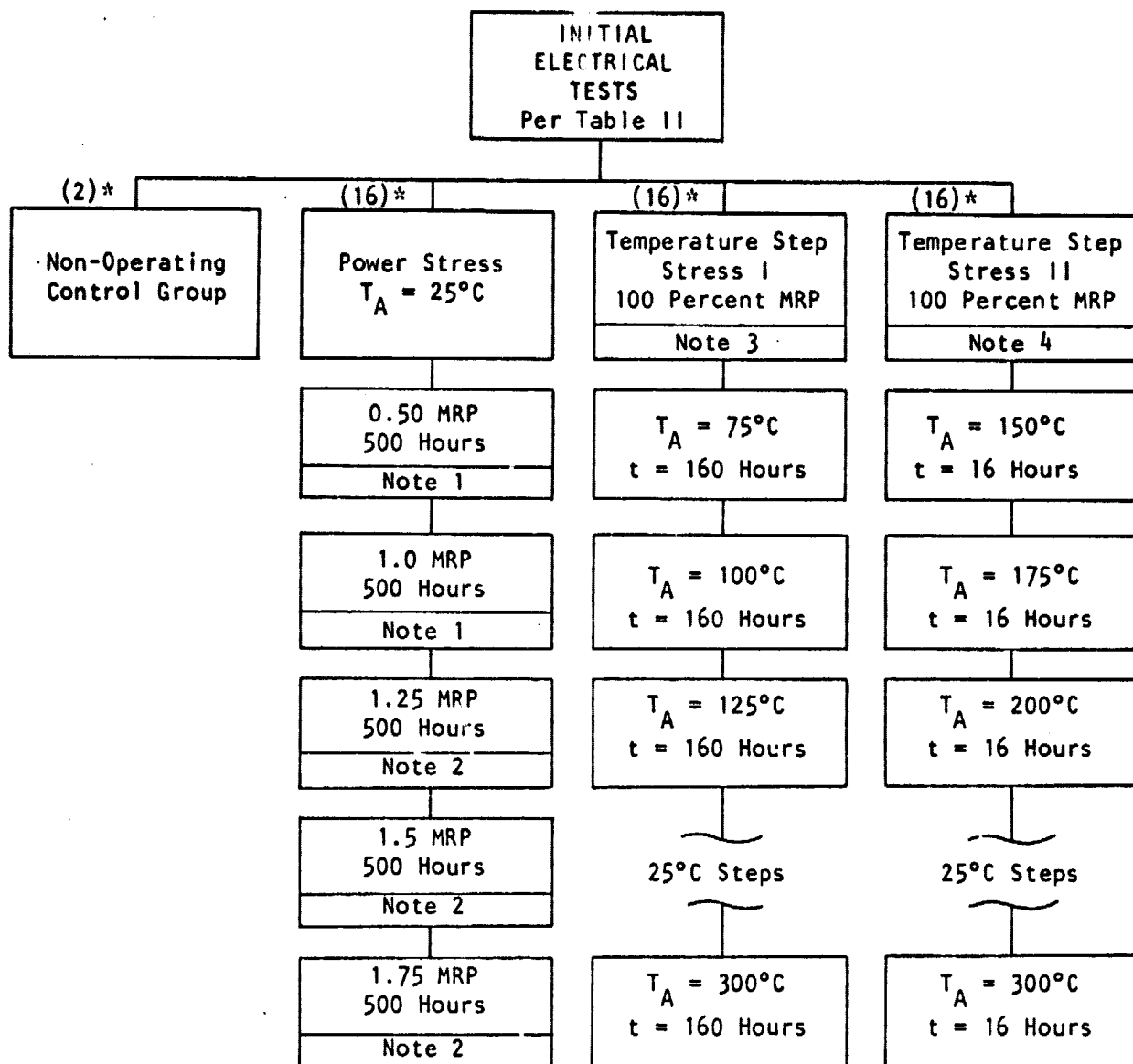
$$T_J \approx T_A + 175^\circ\text{C}$$

TIME (HOURS)

FIGURE 5

Time Steps Versus Junction Temperature, Micro Semiconductor

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TABLE I
TEST FLOW DIAGRAM

*Quantity per manufacturer (Semtech and Micro-Semiconductor)

NOTES:

- 1) Electrical measurements per Table II were made at 50, 150, 250 and 500 hours.
- 2) Electrical measurements per Table II were made at 10, 25, 50, 150, 250 and 500 hours.
- 3) Electrical measurements per Table II were made at the end of each 160 hours.
- 4) Electrical measurements per Table II were made at the end of each 16 hours.



TABLE II
PARAMETERS AND TEST CONDITIONS

PARAMETER	CONDITIONS	SPEC. LIMIT		CAT. LIMIT ¹		UNITS
		MIN	MAX	MIN	MAX	
I_R	@ $V_R = 600V$	—	0.5		50.0	μA
V_F	@ $I_F = 3A$ (Pulsed)	0.8	1.6	0.4	2.4	V

NOTES:

1. In addition, any open or short shall be considered catastrophic.

TABLE III
POWER STRESS BURN-IN CONDITIONS

$V_F = 1.0V$	
$I_F =$	Percent P_D
0.6A	50
1.2A	100
1.5A	125
1.8A	150
2.1A	175



NOTE
FOR TABLES
4 THROUGH 7

The minimum/maximum initial and final data generally have an absolute accuracy of $\pm 1\%$ of the reading and $\pm$ one digit except for readings greater than 9.99mA which have an absolute accuracy of $\pm 2\%$ of the reading and $\pm$ one digit. The data also has a resolution for four digits. The standard deviations, means, delta means, and average means are, therefore, valid indicators of trends over time and temperature, excepting the minor statistical computer error of supplying a constant number of significant digits.



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TABLE IV
GROUP I - POWER STRESS DATA SUMMARY

Page 1 of 2

Page 1 of 2

PARAMETER	$I_R = 0.5\mu A$ (max)		$V_F = 0.8V$ (min) 1.6V (max)					
CONDITIONS AND LIMIT	$V_R = 600V$		$I_F = 3A$ (Pulsed)					
IDENTIFICATION	SEMTECH	MICRO SEMI- CONDUCTOR	SEMTECH	MICRO SEMI- CONDUCTOR				
INITIAL DATA								
MIN VALUE	25.40nA	99.90nA	1.110 V	1.220 V				
MAX VALUE	227.00nA	264.00nA	1.460 V	1.430 V				
MEAN	81.82nA	157.20nA	1.190 V	1.317 V				
STD DEV	58.99nA	37.12nA						
INTERIM DATA								
POWER 50 TO 125% Δ MEAN VALUE								
50% POWER								
50 hrs	-7.20nA	-17.3nA	- 1.0mV	- 1.0mV				
150 hrs	-7.13nA	-17.1nA	20.0mV	16.0mV				
250 hrs	0.09nA	-21.3nA	18.0mV	16.0mV				
500 hrs	0.19nA	1.5nA	18.0mV	15.0mV				
100% POWER								
550 hrs	- 6.98nA	-34.1nA	-17.0mV	- 9.0mV				
650 hrs	13.95nA	- 5.5nA	20.0mV	24.0mV				
750 hrs	4.43nA	-19.3nA	15.0mV	19.0mV				
1000 hrs	8.00nA	-21.2nA	16.0mV	24.0mV				
125% POWER								
1010 hrs	1.17nA	-30.8nA	12.0mV	14.0mV				
1025 hrs	3.12nA	-27.8nA	19.0mV	20.0mV				
1050 hrs	2.78nA	-29.1nA	26.0mV	17.0mV				
1150 hrs	3.18nA	-35.4nA	17.0mV	19.0mV				
1250 hrs	9.74nA	-27.9nA	28.0mV	32.0mV				
1500 hrs	14.39nA	-27.0nA	-14.0mV	-14.0mV				

(continued on second sheet)

15

15 JAN 1960 11:00 AM

JAN 1960



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TABLE IV (Cont'd)

(continued from first sheet)

GROUP I - POWER STRESS DATA SUMMARY

Page 2 of 2

PARAMETER	$I_R = 0.5\mu A$ (max)		$V_F = 0.8V(min) 1.6V(max)$					
CONDITIONS AND LIMITS	$V_R = 600V$		$I_F = 3A$ (Pulsed)					
IDENTIFICATION	SEMTECH	MICRO SEMI- CONDUCTOR	SEMTECH	MICRO SEMI- CONDUCTOR				
INITIAL DATA								
MIN VALUE	25.40nA	99.90nA	1.110 V	1.220 V				
MAX VALUE	227.00nA	264.00nA	1.460 V	1.430 V				
MEAN	81.82nA	157.20nA	1.190 V	1.317 V				
STD DEV	58.99nA	37.12nA						
INTERIM DATA								
POWER 150 TO 175% Δ MEAN VALUE								
150% POWER								
1510 hrs	25.78nA	- 9.5nA	26.0mV	36.0mV				
1525 hrs	27.18nA	1.0nA	27.0mV	33.0mV				
1550 hrs	28.38nA	11.5nA	26.0mV	32.0mV				
1650 hrs	27.68nA	-43.5nA	15.0mV	3.0mV				
1750 hrs	19.08nA	JOB STOPPED	34.0mV	JOB STOPPED				
2000 hrs	44.48nA		31.0mV					
175% POWER								
2010 hrs	42.08 nA	↓	29.0mV	↓				
2025 hrs	40.38 nA	↓	29.0mV	↓				
2050 hrs	23.98 nA	↓	32.0mV	↓				
2150 hrs	7.965μA	↓	31.0mV	↓				
2250 hrs	33.48 nA	↓	36.0mV	↓				
2500 hrs	74.78 nA	↓	- 73.0mV	↓				
FINAL DATA								
MIN VALUE	3.88nA	76.30nA	0.000V	1.230 V				
MAX VALUE	524.00nA	176.00nA	1.230V	1.410 V				
MEAN	156.60nA	113.70nA	1.117V	1.320 V				
STD DEV	134.40nA	31.35nA	0.290V					

NOTE: Catastrophic Rejects removed from data.

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TABLE V
GROUP II - TEMPERATURE STRESS DATA SUMMARY

JANTX1N5619

(160 HR)

PARAMETERS	$I_R = 0.5\mu A$ (max)		$V_F = 0.8V(min) 1.6V(max)$	
CONDITIONS AND LIMITS	$V_R = 600V$		$I_F = 3A$ (Pulsed)	
IDENTIFICATION	SEMTECH	MICRO SEMI-CONDUCTOR	SEMTECH	MICRO SEMI-CONDUCTOR
INITIAL DATA				
MIN VALUE	28.30nA	97.00nA	1.110 V	1.310 V
MAX VALUE	97.00nA	233.00nA	1.370 V	1.550 V
MEAN	55.50nA	155.50nA	1.214 V	1.407 V
STD DEV	21.19nA	40.97nA		
INTERIM DATA (INITIAL TO FINAL)				
Δ MEAN VALUE				
Total Hrs Temp (T_A)				
160 +75°C	- 1.020nA	350.40nA	8.0mV	11.0mV
320 +100°C	- 3.030nA	823.75 μA	10.0mV	110.0mV
480 +125°C	2.890nA	114.55 μA	12.0mV	6.0mV
640 +150°C	- 2.810nA	-102.81nA	15.0mV	-178.0mV

800 +175°C	6.800nA	JOB STOPPED	12.0mV	JOB STOPPED
960 +200°C	624.450 μA	↓ ↓	6.0mV	↓ ↓
1120 +225°C	2.831mA		-19.0mV	

1280 +250°C	JOB STOPPED		JOB STOPPED	
1440 +275°C	↓ ↓	↓ ↓	↓ ↓	↓ ↓
1600 +300°C				
FINAL DATA				
FINAL TEMP (T_A)	225°C	150°C	225°C	150°C
MIN VALUE	31.900nA	26.60nA	1.110 V	1.1200 V
MAX VALUE	9.990mA	111.00nA	1.260 V	1.3900 V
MEAN	2.831mA	52.69nA	1.195 V	1.2290 V
STD DEV	4.340mA	23.29nA		

NOTE: CATASTROPHIC REJECTS REMOVED FROM DATA



TABLE VI
GROUP III - TEMPERATURE STRESS DATA SUMMARY

JANTX1N5619

(16 HOUR)

PARAMETERS	$I_R = 0.5\mu A$ (max)		$V_F = 0.8V$ (min) 1.6V(max)	
CONDITIONS AND LIMITS	$V_R = 600V$		$I_F = 3.0A$ (Pulsed)	
IDENTIFICATION	SEMTECH	MICRO SEMI-CONDUCTOR	SEMTECH	MICRO SEMI-CONDUCTOR
INITIAL DATA				
MIN VALUE	18.50nA	94.00nA	1.150 V	1.250 V
MAX VALUE	114.00nA	416.00nA	1.340 V	1.440 V
MEAN	51.31nA	151.00nA	1.217 V	1.360 V
STD DEV	27.79nA	76.37nA		
INTERIM DATA (INITIAL TO FINAL)				
Δ MEAN VALUE				
<u>Total Hrs</u> <u>Temp (T_A)</u>				
16 +150°C	3.80nA	- 5.200nA	8.0mV	4.0mV
32 +175°C	15.21nA	15.200nA	2.0mV	9.0mV
48 +200°C	32.82nA	8.444μA	2.0mV	14.0mV
64 +225°C	28.59nA	- 9.500nA	7.0mV	6.0mV
80 +250°C	44.86nA	2.900nA	- 3.0mV	1.0mV
96 +275°C	191.09nA	38.070μA	- 5.0mV	- 4.0mV
112 +300°C	190.55μA	11.600nA	2.0mV	- 8.0mV
FINAL DATA				
FINAL TEMP (T_A)	300°C	300°C	300°C	300°C
MIN VALUE	26.90nA	77.2nA	1.150 V	1.280 V
MAX VALUE	2.84mA	396.0nA	1.330 V	1.440 V
MEAN	190.60μA	162.6nA	1.219 V	1.352 V
STD DEV	685.90μA	110.9nA		

NOTE: CATASTROPHIC REJECTS REMOVED FROM DATA



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TABLE VII
FINAL DATA SUMMARY

PARAMETER	SPECIFICATIONS LIMIT		U N I T S	MEAN INT. DATA	AVERAGE Δ IN MEAN VALUE					
	MIN	MAX			POWER STRESS		TEMPERATURE STRESS I		TEMPERATURE STRESS II	
					SEMTECH	MICRO SEMI- CONDUCTOR	SEMTECH	MICRO SEMI- CONDUCTOR	SEMTECH	MICRO SEMI- CONDUCTOR
I _R	-	.5	μA		+.32277	-.01960	+493.64	+234.64	-27.267	+6.6470
V _F	.8	1.6	V		+.01615	+.01644	+.00629	-.01275	+.00186	-.00314

NOTE: Catastrophic reject(s) removed from data.

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TABLE VIII STEP STRESS CATASTROPHIC FAILURE SUMMARY

JAN TX1N5619

GROUP I POWER STRESS

TEST STEP	MFR A		MFR B	
	QTY.	NOTE	QTY.	NOTE
50% 50 hr.	0	-	0	-
100 hr.	0	-	0	-
100 hr.	0	-	0	-
250 hr.	0	-	0	-
100% 50 hr.	0	-	0	-
100 hr.	0	-	0	-
100 hr.	0	-	0	-
250 hr.	0	-	0	-
125% 10 hr.	0	-	0	-
15 hr.	0	-	0	-
25 hr.	0	-	0	-
100 hr.	0	-	0	-
100 hr.	0	-	1	C
250 hr.	0	-	3	C
150% 10 hr.	0	-	0	-
15 hr.	0	-	1	C
25 hr.	0	-	0	-
100 hr.	0	-	5	C
100 hr.	0	-	JOB STOPPED	
250 hr.	0	-		
175% 10 hr.	0	-		
15 hr.	0	-		
25 hr.	0	-		
100 hr.	1	A		
100 hr.	0	-		
250 hr.	1	B		

GROUP II 160 HR. TEMP. STEPS

TEST STEP (T _A)	MFR A		MFR B	
	QTY.	NOTE	QTY.	NOTE
75°C	0	-	0	-
100°C	0	-	2	A
125°C	0	-	0	-
150°C	0	-	2	A
175°C	0	-	1	A
200°C	1	A	3	A
225°C	7	A	JOB STOPPED	
250°C	JOB STOPPED			
275°C				
300°C				

GROUP III 16 HR. TEMP. STEPS

TEST STEP (T _A)	MFR A		MFR B	
	QTY.	NOTE	QTY.	NOTE
150°C	0	-	0	-
175°C	0	-	0	-
200°C	0	-	1	A
225°C	0	-	0	-
250°C	0	-	0	-
275°C	0	-	1	A
300°C	2	A	2	C

MFR A - SEMTECH

MFR B - MICRO-SEMICONDUCTOR

NOTES:

- (A) $I_R > 50$ A
(B) $V_F < 0.4$ V
(C) Visual (other than handling)

TABLE IX STEP STRESS PARAMETRIC FAILURE SUMMARY

JAN TX1N5619

GROUP I POWER STRESS

TEST STEP	MFR A		MFR P	
	QTY.	NOTE	QTY.	
5% 50 hr.	0	-	0	-
100 hr.	0	-	0	-
100 hr.	0	-	0	-
250 hr.	0	-	0	-
100% 50 hr.	0	-	0	-
100 hr.	0	-	0	-
100 hr.	0	-	0	-
250 hr.	0	-	0	-
125% 10 hr.	0	-	0	-
15 hr.	0	-	0	-
25 hr.	0	-	0	-
100 hr.	0	-	0	-
100 hr.	0	-	0	-
250 hr.	0	-	0	-
150% 10 hr.	0	-	0	-
15 hr.	0	-	0	-
25 hr.	0	-	0	-
100 hr.	0	-	0	-
100 hr.	0	-	JOB STOPPED	
250 hr.	1	A		
175% 10 hr.	0	-		
15 hr.	0	-		
25 hr.	0	-		
100 hr.	1	A		
100 hr.	0	-		
250 hr.	0	-		

GROUP II 160 HR. TEMP. STEPS

TEST STEP (TA)	MFR A		MFR B	
	QTY.	NOTE	QTY.	NOTE
75°C	0	-	1	A
100°C	0	-	0	-
125°C	0	-	1	A
150°C	0	-	0	-
175°C	0	-	JOB STOPPED	
200°C	0	-		
225°C	2	A		
250°C	JOB STOPPED			
275°C				
300°C				

NOTES:

(A) I_R Limit Failure

GROUP III 16 HR. TEMP. STEPS

TEST STEP (TA)	MFR A		MFR B	
	QTY.	NOTE	QTY.	NOTE
150°C	0	-	0	-
175°C	0	-	0	-
200°C	0	-	0	-
225°C	0	-	0	-
250°C	0	-	0	-
275°C	1	A	1	A
300°C	2	A	0	-

MFR A - SEMTECH

MFR B - MICRO-SEMICONDUCTOR



JANTX1N5619

APPENDIX A
FAILURE ANALYSIS
POWER STRESS



MSFC STEP-BY-STEP TEST
FAILURE ANALYSIS- DIODES

JANTX1N5619

Date 16 September 1978

J/N: 2CN242-18A

P/N: 1N5619

MFR: Micro Semiconductor

FAILURE VERIFICATION:

Limit:
50uA

Limits:
0.4 to 2.4V

S/N	PIV -volts-	I_r @ 600 V.dc	V_f @ 3.0A dc	INITIAL REJ. @ Seq. #:	INITIAL REJ. FOR:
7743	1100 D	45 nA	1.6V	MP-14	Lead off.
7745	1200	130 nA	1.5V	MP-15	Lead off.
7746	720	290 nA	1.5V	MP-19	Lead off.

INTERNAL VISUAL INSPECTION:

All three samples had a missing external cathode lead which became detached from the diode internal heat sink.

The detached end of each wire shows bare copper. (See Figure A-1.)

CONCLUSIONS:

These Micro Semiconductor samples have failed for visual defects before reaching the point of electrical failure. The bare ends of the detached cathode wires appear to have been poorly wet. It is not known why the failure is preferential to the cathode wire on these three samples.



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OF POOR QUALITY



FIGURE A-1
S/N 7743. Magnification 14X
Typical failure site of cathode wire on
Micro-Semiconductor parts.



FIGURE A-2
S/N 7716. Magnification 14X.
Appearance of glass diode body
showing missing external paint.



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APPENDIX B
FAILURE ANALYSIS
TEMPERATURE STRESS

MSFC STEP-STRESS TEST

JANTX1N5619

FAILURE ANALYSIS- DIODESDate 14 September 1978J/N: 2CN242-18BP/N: 1N5619MFR: SemtechFAILURE VERIFICATION:Limit:
50uALimits:
0.4 to 2.4V

S/N	PIV -volts-	I_r @ 600 V.dc	V_f @ 3.0A dc	INITIAL REJ. @ Seq. #:	INITIAL REJ. FOR:
7697	370 → 100 S	> 10mA *	1.18V	MP-8	I_R
7722	480	> 16mA	1.38V	MP-7	I_R
7723	320 → 100 S	> 10mA *	1.18V	MP-8	I_R
		* Cannot reach 600 V.			

INTERNAL VISUAL INSPECTION:

No visual anomalies were found other than missing external paint. (See Figure B-1.)

GLASS CONDUCTIVITY TEST:

No conductivity was seen when the glass body was tested at 600 volts.

CONCLUSION:

S/N 7722 fails the 600 volt I_R test because this device has a 480 volt breakdown voltage. The curve trace is free of leakage until 330 volts; from there to 480 volts the curve is rounded, and then a final hard breakdown occurs at 480 volts. Since the sample was acceptable at 600 volts previous to rejection at measurement point 8, this suggests that the stress test has caused bulk silicon damage. This has caused microplasma formations which are activated at 330 and 480 volts, respectively.

S/N 7723 and 7697 have initial breakdown voltages which are below 400 volts, and which decline as the applied voltage is increased. This indicates that these samples have bulk silicon damage similar to S/N 7722. The low V_F 's confirm that a partial junction short is being activated during the high current tests.

MSFC STEP-STRESS TEST

JANTX1N5619

FAILURE ANALYSIS- DIODESDate 15 September 1978J/N: 2CN242-18BP/N: 1N5619MFR: Micro SemiconductorFAILURE VERIFICATION:

Limit:

50 uA max.

Limits:

0.4 to 2.4 V

S/N	PIV -volts-	I_r @ 600 V.dc	V_f @ 3.0A dc	INITIAL REJ. Seq. #:	INITIAL REJ. FOR:
7761	950 D @1.0mA	0-350 uA *	1.35 V	MP-4	I_R
		* Drifts up			
7765	1100	62 uA	1.45 V	MP-4	I_R
7757	R	900 uA	1.45 V	MP-3	I_R
		(neg.resist.)			

INTERNAL VISUAL INSPECTION:

All three samples exhibit cracked glass. (See Figure B-2.)

The metal holding the anode wire of S/N 7767 is cracked and partly chipped out. (See Figure B-3.)

CONCLUSIONS:

These three samples failed due to surface problems arising from loss of hermeticity when their glass cases cracked.



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FIGURE B-1
S/N 04. Magnification 15X.
Typical diode appearance showing missing
external paint. Semtech sample.

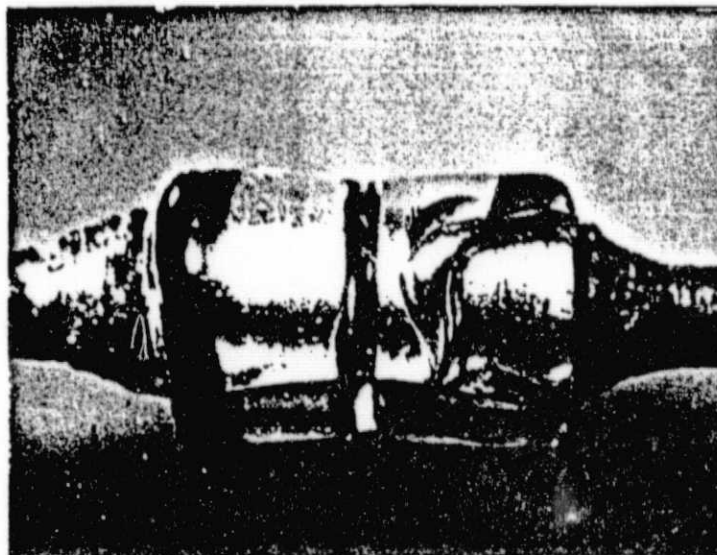


FIGURE B-2
S/N 7767. Magnification 17X.
Typical cracked glass on Micro-Semiconductor samples.



JANTX1N5619



FIGURE B-3
S/N 7767. Magnification 20X.
Cracked and chipped-out solder at external
anode wire attachment. Micro-Semiconductor sample.

ORIGINAL IN
OF PHOTOGRAPHY